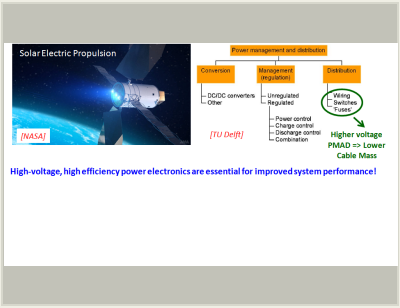
Small Business Innovation Research/Small Business Tech Transfer

Radiation and High Temperature Tolerant GaN Power Electronics, Phase I

Completed Technology Project (2017 - 2017)

Project Introduction

Power electronic components with high operating voltages are desirable in NASA Power Management and Distribution (PMAD) systems since they can lead to reduced mass and higher efficiency at the system architecture level, and serve as an enabling technology for solar electric propulsion systems. Gallium nitride (GaN) offers significant advantages over silicon (Si) technologies for power applications including higher breakdown voltage and power density, rapid switching, lower switching losses, and higher temperature tolerance. Enhancement mode GaN-on-Si high electron mobility transistors (HEMTs) are a rapidly advancing technology that are scalable with voltage, offer superior electrical performance, and also demonstrate high tolerance to displacement damage and total ionizing dose (TID). However, prior tests have shown that heavy ion (HI) induced leakage currents and catastrophic damage may occur well below rated voltages. A thorough investigation of the HI response of emerging, higher voltage GaN HEMTs and underlying mechanisms is essential to develop radiation tolerant devices for space applications. CFDRC, in collaboration with Vanderbilt University and EPC, proposes to use an integrated experimental and physics-based modeling approach to address this challenge. In Phase I, we will perform heavy ion testing of commercial EPC GaN HEMTs to generate response data. Detailed TCAD models will be developed for the HEMT structure to investigate physical mechanisms behind measured radiation response. In Phase II, we will perform additional heavy ion and TID testing as a function of temperature and bias. Extensive TCAD and higher-fidelity modeling will be performed to determine radiation and temperature-dependent mechanisms, and to investigate device design modifications for improved radiation tolerance. Promising solutions will be prototyped and characterized via testing. Participation by EPC in Phase II and beyond will ensure advanced space-qualified, GaN power devices.



Radiation and High Temperature Tolerant GaN Power Electronics, Phase I Briefing Chart Image

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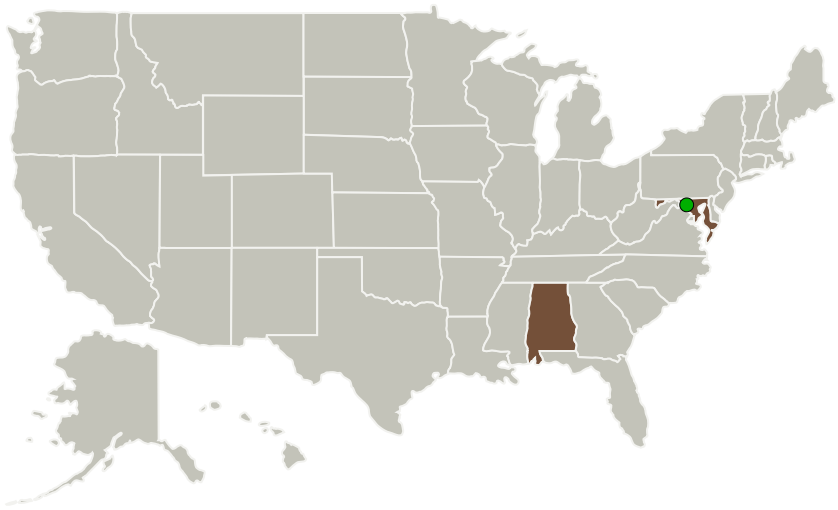
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Alabama	Maryland

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

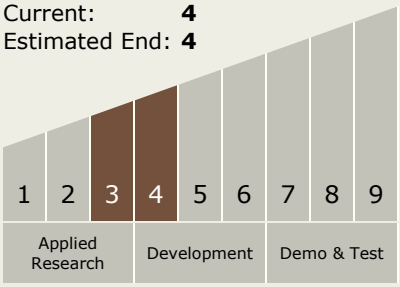
Carlos Torrez

Principal Investigator:

Robert Arslanbekov

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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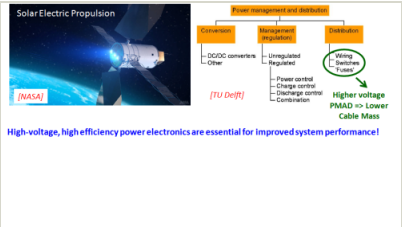
Images



Briefing Chart Image
Radiation and High Temperature Tolerant GaN Power Electronics, Phase I Briefing Chart Image *(https://techport.nasa.gov/image/131694)*

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.2 Radio Frequency
    - TX05.2.2 Power-Efficiency

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System